Chapter 3 – The Science Content Standards
High School (Grades 9-12): Investigation and Experimentation

INTRODUCTION

Investigation and experimentation forms the foundation of science knowledge. Teachers must convey the skills and knowledge needed to perform investigations and experiments. The Investigation and Experimentation standards allow students to make concrete associations between science and the study of nature, as well as to provide many opportunities to take measurements and use basic mathematics. In the high school sequence teachers implement these standards in the context of physics, chemistry, biology/life sciences, and earth sciences.

Investigations and experiments engage scientists, catalyzing their highest levels of creativity, and producing their most satisfying rewards. The possibility of discovery or adding new science knowledge in the form of facts, concepts, principles or theories offers a great sense of accomplishment and wonder. Investigation and experimentation can be just as engaging to high school students as they study science. Although they may not discover something new to the scientific community, they may find pleasure in discovering something new to themselves, or seeing the content from their science text illuminated in practice. Accordingly they can experience the pride of creating experimental protocols and realize the joy of discovery and learning.

Teachers need to know and teach the details of the scientific processes addressed by the Investigation and Experimentation standards. To be valid, an experiment needs to have controls that minimize sources of error and provide reproducible results. Teachers should select experiments and demonstrations that are standards-based and well tested, rather than unguided or disorganized "expeditions." Taught effectively, the study of science can be engaging for high school students. Some principles are best pre-taught explicitly by direct instruction, then demonstrated with a hands-on activity that reinforces the teaching. Other principles may be easily discovered by students, and teachers should not rob them of the pleasure of finding out for themselves. The teacher must be certain that every investigative activity reinforces content and sound thinking.

Text of the Standards

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content of the other four strands, students should develop their own questions and perform investigations. Students will:

a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
b. Identify and communicate sources of unavoidable experimental error.
c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
d. Formulate explanations by using logic and evidence.
e. Solve scientific problems by using quadratic equations, and simple trigonometric,

exponential, and logarithmic functions.

f. Distinguish between hypothesis and theory as scientific terms.

g. Recognize the usefulness and limitations of models and theories as scientific representations of reality.

h. Read and interpret topographic and geologic maps.

i. Analyze the locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).

j. Recognize the issues of statistical variability and the need for controlled tests.

k. Recognize the cumulative nature of scientific evidence.

l. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.

m. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.

n. Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e.g., Piltdown Man fossil or unidentified flying objects), and that the theory is sometimes wrong (e.g., Ptolemaic model of the movement of the Sun, Moon and planets).